lation angle of the waveguide light can be finely varied. Therefore, by varying the emitting positions of the light beams from the two converging grating couplers, the converged spot can be allowed to trace on the track.

According to the eight embodiment as mentioned above, in addition to the effects of the foregoing seventh embodiment, the change-over of the waveguide lights which enter the converging grating couplers and the tracking control can be executed by the SAW transducer **91**. Thus, the optical head can be simplified and the number of manufacturing steps can be reduced.

Since the surface acoustic wave **92** is located between the fourth beam splitter **93** and the two converging grating couplers, the return waveguide light from the optical disc **1** is not influenced by the tracking control on the optical path after the surface acoustic wave **92**. Therefore, the converging position on the third photo detector is not moved by the tracking control, so that a deterioration in photo detection signal can be prevented.

In the embodiment, although the SAW transducer has been used as both of the optical path switching means and the optical path deflecting means for tracking control, the SAW transducer can be also provided for the optical head only for the tracking control. For instance, it is also possible to form the SAW transducer for the sixth optical head **60** in the fifth embodiment or the seventh optical head **80** in the sixth embodiment and to execute the tracking control.

We claim:

1. An optical recording/reproducing apparatus for recording, reproducing or erasing an information signal by converging a light flux onto/from a recording layer through a transparent disc substrate, comprising:

(a) N optical heads, N being greater than or equal to 2, each comprising:

light emitting means,

objective lenses, whose aberrations have respectively been corrected for said N disc substrates having different thicknesses, each for converging the light flux which is emitted from the light emitting means onto the optical disc, and

a plurality of photo detecting means each for detecting the reflected light from the optical disc;

(b) N optical head moving means which are arranged below the optical disc and move the N optical heads in the radial direction of the optical disc;

(c) disc discriminating means for discriminating the thickness of the disc substrate of the loaded optical disc and for generating a discrimination signal in accordance with the result of the discrimination; and

(d) control means for selecting the optical head having the objective lens in which the occurrence of the aberration due to the disc substrate is smallest in accordance with the discrimination signal,

wherein the selected optical head records, reproduces or erases the information signal onto/from the optical disc.

2. An apparatus according to claim **1**, further comprising backward moving means for moving the non-selected optical heads to the outside of the optical disc for a period of time when the optical head which has been selected by the control means is recording, reproducing, or erasing the information signal.

3. An apparatus according to claim **1**, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

4. An apparatus according to claim **2**, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

5. An apparatus according to claim **1**, wherein numerical apertures of at least two or more of said N objective lenses differ.

6. An apparatus according to claim **2**, wherein numerical apertures of at least two or more of said N objective lenses differ.

7. An optical recording/reproducing apparatus for recording, reproducing or erasing an information signal by converging a light flux onto/from a recording layer through a transparent disc substrate, comprising:

(a) an optical head having N, N being greater than or equal to 2, converging optical systems each comprising:

light emitting means,

objective lenses, whose aberrations have respectively been corrected for said N disc substrates having different thicknesses, each for converging the light flux which is emitted from the light emitting means onto the optical disc, and

a plurality of photo detecting means each for detecting the reflected light from the optical disc;

(b) optical head moving means which is arranged below the optical disc and moves the optical head in the radial direction of the optical disc;

(c) disc discriminating means for discriminating the thickness of the disc substrate of the loaded optical disc and for generating a discrimination signal in accordance with the result of the discrimination; and

(d) control means for allowing the light emitting means, which belongs to the converging optical system in which the occurrence of the aberration due to the disc substrate is smallest in accordance with the discrimination signal, to emit light,

wherein the selected converging optical system records, reproduces or erases the information signal onto/from the optical disc.

8. An apparatus according to claim **7**, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

9. An apparatus according to claim **7**, wherein numerical apertures of at least two or more of said N objective lenses differ.

10. An optical recording/reproducing apparatus for recording, reproducing or erasing an information signal by converging a light flux onto/from a recording layer through a transparent disc substrate, comprising:

(a) an optical head including:

light emitting means,

light flux dividing means which are arranged in the light flux from the emitting means and divide the emitted light flux into N, N being greater than or equal to 2, light fluxes and deflect in different directions,

N objective lenses, whose aberrations have respectively been corrected for said N disc substrates having different thicknesses, for respectively converging said N light fluxes onto the optical disc,

light flux selecting means for selecting one of the N light fluxes divided by the light flux dividing means and for allowing said light flux to pass, and

photo detecting means for detecting the light fluxes reflected by the optical disc;

(b) optical head moving means which is arranged below the optical disc and moves the optical head in the radial direction of the optical disc;

(c) disc discriminating means for discriminating the thickness of the disc substrate of the loaded optical disc and for generating a discrimination signal in accordance with the result of the discrimination; and

(d) control means for generating a control signal to the light flux selecting means in accordance with the discrimination signal and for selecting the light flux which passes through the objective lens in which the occurrence of the aberration due to the disc substrate is smallest,

wherein the optical head records, reproduces or erases the information signal onto/from the optical disc by the selected light flux.

11. An apparatus according to claim 10, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

12. An apparatus according to claim 10, wherein numerical apertures of at least two or more of said N objective lenses differ.

13. An optical recording/reproducing apparatus for recording, reproducing or erasing an information signal by converging a light flux onto/from a recording layer through a transparent disc substrate, comprising:

(a) an optical head including:

an optical waveguide formed on a substrate,

N light emitting means each for emitting a waveguide light into said optical waveguide, N being greater than or equal to 2,

N converging grating couplers, whose aberrations have respectively been corrected for said N disc substrates having different thicknesses, each for emitting the waveguide light supplied from said N light emitting means to the outside of the optical waveguide and for allowing the reflected light from the optical disc to enter, and

N photo detecting means each for detecting reflected light and for generating an information signal;

(b) optical head moving means which is arranged below the optical disc and moves the optical head in the radial direction of the optical disc;

(c) selecting means for selecting the light emitting means to be allowed to emit the light from among the N emitting means;

(d) disc discriminating means for discriminating the thickness of the disc substrate of the loaded optical disc and for generating a discrimination signal according to the result of the discrimination; and

(e) control means for generating a control signal in accordance with the discrimination signal, for providing said control signal to said selecting means and for allowing the light emitting means for emitting the waveguide light into the converging grating coupler in which the occurrence of the aberration due to the disc substrate is smallest,

wherein the optical head records, reproduces or erases the information signal onto/from the optical disc by the light flux from the selected light emitting means.

14. An apparatus according to claim 13, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

15. An apparatus according to claim 13, wherein numerical apertures of at least two or more of the N converging grating couplers differ.

16. An optical recording/reproducing apparatus for recording, reproducing or erasing an information signal by converging a light flux onto/from a recording layer through a transparent disc substrate, comprising:

(a) an optical head including:

an optical waveguide formed on a substrate,

light emitting means for emitting a waveguide light into said optical waveguide,

light flux dividing means for dividing the waveguide light emitted from the light emitting means into N divided waveguide lights, N being greater than or equal to 2,

said N converging grating couplers, whose aberrations have respectively been corrected for said N disc substrates having different thicknesses, each for emitting each of said N divided waveguide lights to the outside of the optical waveguide and for allowing the reflected light from the optical disc to enter, and

N photo detecting means for respectively detecting said reflected lights from the N converging grating couplers and for generating information signals;

(b) optical head moving means which is arranged below the optical disc and moves the optical head in the radial direction of the optical disc;

(c) output switching means for selecting and outputting one of the output signals of said N photo detecting means;

(d) disc discriminating means for discriminating the thickness of the disc substrate of the loaded optical disc and for generating a discrimination signal in accordance with the result of the discrimination; and

(e) control means for generating a control signal to the output switching means in accordance with the discrimination signal and for selecting the photo detecting means into which the waveguide light enters from the converging grating coupler in which the occurrence of the aberration due to the disc substrate is smallest.

17. An apparatus according to claim **16**, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

18. An apparatus according to claim **16**, wherein numerical apertures of at least two or more of the N converging grating couplers differ.

19. An optical recording/reproducing apparatus for recording, reproducing or erasing an information signal by converging a light flux onto/from a recording layer through a transparent disc substrate, comprising:

(a) an optical head including:

an optical waveguide formed on a substrate,

light emitting means for emitting a waveguide light into said optical waveguide,

optical path switching means which is arranged on an optical path of said waveguide light and switches the propagating direction of the waveguide light in N directions in accordance with a control signal, N being greater than or equal to 2,

N converging grating couplers, whose aberrations have respectively been corrected for said N disc substrates having different thicknesses and which are respectively arranged in said N propagating directions which are switched by said optical path switching means and emit the waveguide light to the outside of the optical waveguide and allow the reflected light from the optical disc to enter, and

photo detecting means for detecting the reflected light and generating an information signal;

(b) optical head moving means which is arranged below the optical disc and moves the optical head in the radial direction of the optical disc;

(c) disc discriminating means for discriminating the thickness of the disc substrate of the loaded optical disc and for generating the discrimination signal in accordance with the result of the discrimination; and

(d) control means for generating a control signal to the optical path switching means in accordance with the discrimination signal and for switching the propagating direction of the waveguide light from the light emitting means to the direction of the converging grating coupler in which the occurrence of the aberration due to the disc substrate is smallest,

wherein the optical head records, reproduces or erases the information signal onto/from the optical disc by the light flux emitted from the selected converging grating coupler.

20. An apparatus according to claim **19**, wherein said optical path switching means combines deflecting means for changing the propagating direction of the waveguide light by a deflection angle according to a input signal,

and wherein said apparatus comprises:

tracking error detecting means for detecting a tracking error amount of a converged spot which has been converged onto the optical disc and for generating a tracking error signal; and

tracking control means for changing the input signal to the deflecting means in accordance with said tracking error signal and for eliminating the tracking error of the converged spot.

21. An apparatus according to claim **19**, wherein said disc discriminating means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

22. An apparatus according to claim **20**, wherein said disc discrimination means comprises:

a cartridge for enclosing the optical disc;

a discrimination hole which is formed on the cartridge and whose opening/closing state differs in correspondence to the thickness of the disc substrate of the optical disc; and

detecting means for detecting the opening/closing state of the discrimination hole and for generating a discrimination signal.

23. An apparatus according to claim **19**, wherein numerical apertures of at least two or more of the N converging grating couplers differ.

24. An apparatus according to claim **20**, wherein numerical apertures of at least two or more of the N converging grating couplers differ.

* * * * *

25. A method of recording/reproducing an information signal onto/from N types (where N ≥ 2) of optical discs having first layers of different thicknesses, each of said optical discs having at least said first layer which is transparent and a second layer which is for storing information, said method comprising:

(a) emitting a light flux from a semiconductor laser,

(b) converging said light flux on said second layer of one disc of said N types of optical discs by employing a converging optical system having at least one of (i) different effective numerical apertures, (ii) different focal distances, and (iii) different working distances, wherein said converging optical system selects one of (i) a particular one of said different effective numerical apertures, (ii) a particular one of said different focal distances, and (iii) a particular one of said different working distances in accordance with the thickness of said first layer of said one disc of said N types of optical discs,

(c) receiving said light flux reflected from said one disc by a photo detector, and

(d) generating a reproduction signal from said photo detector in accordance with said received light flux.

26. The method according to claim 25, further comprising discriminating the type of said one disc among said N types of optical discs by said reproduction signal from said photo detector.

27. The method according to claim 25, wherein said converging optical system comprises an objective lens and said working distances are defined as the distance between a surface of a said optical disc and the nearest surface of said objective lens.

28. The method according to claim 26, wherein step (b) comprises operating said converging optical system to converge said light flux as a spot with a smaller diameter D by employing one of (a) a larger one of said effective numerical apertures, (b) a shorter one of said focal distances and (c) a shorter one of said working distances, with respect to one of said optical discs having a thinner one of said first layers in accordance with a result of said step of discriminating the type of said one disc among said N types of optical discs by said reproduction signal from said photo detector.

29. The method according to claim 25, further comprising operating a signal processing unit to generate, responsive to one of (i) receipt of said reproduction signal from said photo detector and (ii) receipt of recording data for recording on said one disk, a signal for performing one of a reproducing operation and a recording operation on said one disc; and controlling generation of the output signal of said signal processing unit.